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during one or more comparatively early stages of the Pleistocene ice from the north advanced over the Columbia Plateau in a southwesterly direction far beyond what heretofore has been regarded as the southern limit of glaciation. The evidence at hand tends to show that the ice extended at least over large parts of Spokane, Lincoln and Adams counties, and less complete information suggests the possibility that the glaciation extended much farther.

Concerning the glacial drift, which by the way is not the only evidence the region affords that land ice was formerly present, the alternative ideas that it was brought to place by floating ice or running water have been considered and rejected.¹ Large patches of the drift may be seen southwest of Cheney, west of Lantz, and in the neighborhoods of Winona, Lacrosse and Kahlotus, these occurrences being selected for mention at random and not because they are more typical than scores of others scattered throughout the region.

The writer wishes to point out that he does not herein attempt to correlate or otherwise define the relations between the glaciation described and the glaciation already known to have covered the plateau west of the Grand Coulee or an ice stream which, as shown by recent observations, traversed the coulee itself.

J. T. PARDEE

U. S. GEOLOGICAL SURVEY

EFFECTS OF COPPER WIRE ON TREES

IN 1918 the writer heard it stated that shade trees were being killed by driving one or two pieces of copper wire into each. To test the effects of copper wire six young trees from two to four inches in diameter were selected, and on March 21, 1919, there were driven into each tree five pieces of large copper wire 1.5 inches long. The end of each wire was left flush with the outer surface of bark. All wires were within six feet of the base of the tree. The trees comprised two hemlocks, two alders, one cedar, one willow.

On July 3, 1922 the trees were examined and found to be perfectly healthy. In all cases they had completely healed over the wires, and their growth was equal to that of other similar

trees in the immediate vicinity. On cutting into the trees, it was found that there was very little injury to the wood, merely a brown color showing for about 1.5 inches above and below the wire, and about 0.25 inch to each side.

GEORGE B. RIGG

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TANGENT LINES

OSGOOD and Graustein state in their *Analytic Geometry*, page 176: "A tangent to a conic might then be defined as the limiting position of a line having two points of intersection with the conic, when these points approach coincidence in a single point." This accords with the ancient idea of a tangent as touching a conic at only one point. That idea is given in a paragraph on page 163 of my *History of Mathematics*, from which Professor G. A. Miller quotes¹ part of a sentence and then criticizes that part. I illustrate this mode of criticizing by quoting from Professor Miller's review the following: "Students can usually prove a large number of theorems which they do not understand." Serious-minded readers would deny this statement, but when they read the whole sentence and the paragraph from which this fragment is taken, they will acquiesce.

FLORIAN CAJORI

SCIENTIFIC BOOKS

A Treatise on the Analysis of Spectra. By W. M. Hicks, Sc.D., F.R.S., emeritus professor of physics in the University of Sheffield, formerly fellow of St. John's College, Cambridge. Cambridge University Press, 1922, 231 pp. of text, 92 pp. of tables and 25 figures.

The purpose of the book is twofold, to serve as an introduction and handbook and to present the mature results of the author's extensive investigations. The treatise is based on an Adams prize essay presented in 1921. For the first purpose the appendix contains the Meggers and Peters tables for corrections to be added to the wave-lengths in air to reduce

¹ This Journal, October 13, page 421.

to vacuum, Rydberg's values of $N/(m + \mu)^2$, data for wave-lengths and wave-numbers of lines allocated to series, and the Hicks formula constants, in Chapter V in which he considers the effects of physical conditions, the various Zeeman patterns so far determined, illustrative of Preston's law, are collected for convenient reference and also the Stark data, and a table of radiation and ionization potentials is included.

Chapters II and III give a clear introduction to types of series and to the series systems now recognized in the different groups of the periodic table. In the following chapter Rydberg's rules are discussed in the light of the series systems now determined and of the available spectroscopic data. With the exception of the constancy of N , he considers that all the values are valid; as to N he concludes that we can not hope to determine exact values of N in the various series and elements from determination of formulae constants alone, that it is practically certain that the value in general is larger than Rydberg's value and nearer Bohr's limit and that changes in N in the different sequences should not be unexpected.

A distinctive contribution by Hicks to the study of series is his modification of the Rydberg formula which he writes $n = A - N/(m + \mu + \alpha/m)^2$ where A is the limit, $\mu + \alpha/m$ the "mantissa," and N 109675 R. U. In his notation the separations from the limit in a series of lines form a "sequence" of values and a particular value is the m th "sequent." Separation is the difference in the wave-numbers of two lines, ν = doublet separation, Δ = the difference in the mantissæ of doublet sequences and is shown to be an integral multiple of the "oun."

The mantissæ play an important rôle in the author's development of the idea of the oun and "linkages." He writes $\Delta = m q w^2$ where m is an integer, q a universal constant, and w the atomic weight, which for convenience he divides by 100. From a consideration of the doublets of Ag he finds that q is 361.78.

The oun is considered to be a fundamental constituent in spectra and is written oun = δ , $\delta = \frac{1}{4}\delta$ where $\delta = 361w^2$. The evidence given

for the dependence of the oun on the square of the atomic weight is very strong, but the existence of isotopes introduces difficulties which the author recognizes but does not succeed in disposing of completely.

When a multiple of the oun is added to the limit mantissa, the modification is called displacement and a displaced line a "collateral." This leads to his theory of linkages, "that in certain elements the spark spectra consist almost wholly of long sets of lines differing from one another in succession by certain special separations which can be calculated from the ordinary series limits and Δ , these separations may be called links, and a complete set of a linkage. These linkages appear to start from ordinary series lines." The subject of linkages is too complicated for presentation in a review; it aims to relate the lines which do not belong to the regular series to lines occurring in the ordinary series by a set of links. These links may occur in any order forming chains and meshes of lines. That "linkage spectra" represent realities and form a category coordinate with series and band spectra would seem to be a matter for further investigation.

The reviewer's impression is that the author over-estimates the accuracy of the spectroscopic data and one wonders whether with more accurate data the evidence for linkages would be increased or lessened. Professor Hicks is convinced that links occur with much greater frequency than a chance arrangement would suggest, but considers the most conclusive evidence to be furnished by the large number of regularities, repetitions, collocations of links and meshes. It is, however, somewhat surprising that lines in spark spectra should be related to each other by separations calculated from the limits and the Δ of the ordinary series inasmuch as spark spectra are characterized by their special types of series.

Chapters VIII and IX are devoted to a discussion of the distinguishing properties of the p and s and of the d and f sequences. For the p sequence the march of the mantissæ and atomic volumes is so close that he concludes that the p sequence depends directly on a quantity equivalent to the volume of the atom. On

the other hand the *d* and *f* sequents have as mantissæ multiples of the *oun*. The last two chapters are given to the monatomic gases and to the consideration of miscellaneous questions.

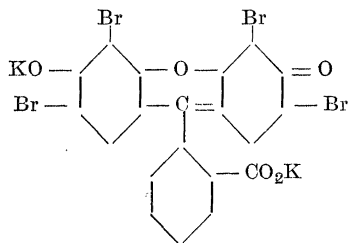
This book by Professor Hicks representing extensive researches for data and extended calculations based on the material collected and giving the views of one who has studied the subject so long and thoroughly will prove a welcome addition to a working library. It presents a general and connected view, provides a means of ready reference and suggests lines of investigation. It is well indexed and replete with references to original sources.

CHARLES E. ST. JOHN

AMERICAN EOSINS

In a recent report of this committee¹ it was mentioned that a number of satisfactory samples of eosin had been obtained from American sources. At the time this early report was published no very definite data were at hand to show how these samples compared with samples of Grüber's eosin. At the present time, however, data have begun to accumulate giving a more satisfactory survey of the whole situation and it seems time to publish them.

Eosin is a compound of the phthalein series with a formula essentially as follows:



There are an almost innumerable number of different eosins on the market, differing slightly in chemical composition and having quite different staining properties and solubilities. They are usually classed in three or four groups denoted in Schultz's Farbstofftabellen, fifth edition, under the numbers 587, 588, 589 and 590.

Eosin 587 is the stain best known to the

biologist. It is typically the same as the formula given above, namely the potassium salt of tetrabromfluorescein; but the monobrom and dibrom derivatives are also known, and as they sometimes occur mixed with the tetrabrom compound, the composition of this dye varies somewhat. Its color varies accordingly, because the more bromine atoms the bluer the shade. This dye is specified in the trade by such terms as eosin, yellowish eosin, eosin Y, and eosin G, water-soluble eosin, eosin W, eosin Y extra, eosin S extra.

Eosin 588 and 589 are both known as alcohol-soluble eosin, being only slightly soluble in water, but differ from each other in that 588 contains a methyl group in the place of one of the potassium atoms in the above formula while 589 contains an ethyl group in this same position. Number 588 is more correctly called methyl eosin while 589 is called eosin S or primrose.

Eosin 590 is a compound in which two of the bromine atoms have been replaced by NO₂-groups. This compound, like 587, is readily soluble in water but differs from it in its bluish color. It is known as bluish eosin, eosin B or eosin BN.

It must be understood that with such great variation in the possible composition, every manufacturer puts on the market a product slightly different from that of any other and as these compounds differ in shade each different product is generally known by its own trade designation. This gives the very confusing list of designations applied to eosin, of which those mentioned above are merely the commoner ones. It simplifies matters, however, if it is remembered that the terms eosin, yellowish eosin or water-soluble eosin refer to 587, while alcohol-soluble eosin refers to 588 or 589 and bluish eosin to 590.

No attempt was made in this work to get uniformity in the technic that was used, each collaborator being asked to use the samples for any purpose and according to any technic with which he was familiar. One of the investigators, in fact, reports five different tests to which he submitted the samples. As a result, these samples have been tested in a great

¹ Committee on Standardization of Stains: "Preliminary Report on American Biological Stains," SCIENCE, N. S., LVI, 156-160.